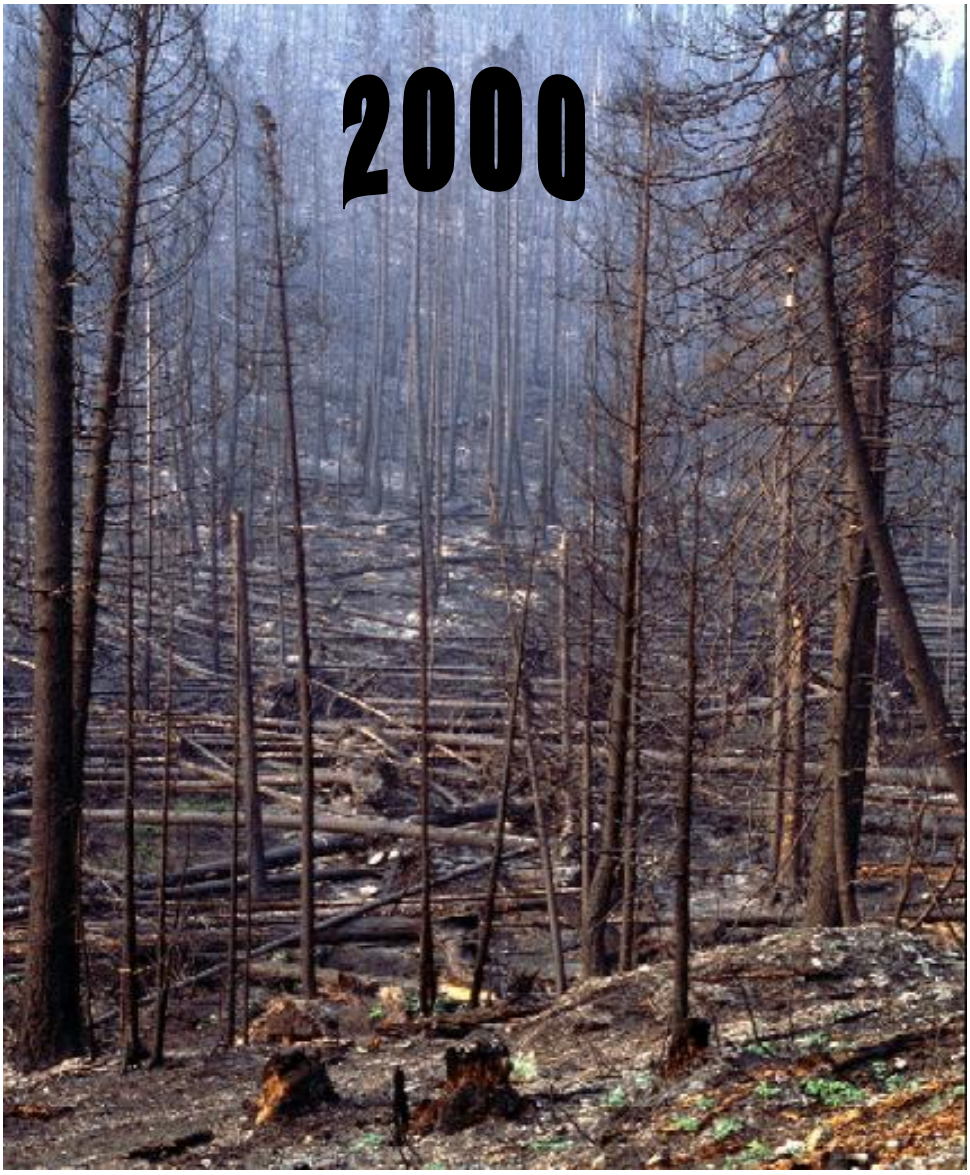
MONTANA
FOREST INSECT AND DISEASE CONDITIONS AND PROGRAM HIGHLIGHTS

United States Department of Agriculture

Forest Service

Northern Region

State and Private Forestry



Report 01-1

Montana Department of Natural Resources and Conservation

Forestry Division

MONTANA

Forest Insect and Disease Conditions and Program Highlights - 2000

Report 01-1

June 2001

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INTRODUCTION

This report summarizes the major forest insect and disease conditions in Montana during 2000 and was jointly prepared by USDA Forest Service, Forest Health Protection (FHP), State and Private Forestry, Northern Region and the Montana Department of Natural Resources and Conservation, Forestry Division. Information for the report was derived from ground and aerial surveys across parts of Montana.

SUMMARY OF CONDITIONS

Douglas-fir beetle caused mortality continued in western Montana. High levels of mountain pine beetle caused mortality occurred in lodgepole pine and second growth ponderosa pine in the same general areas, especially in the western portion of the Lolo National Forest.

Heavy Douglas-fir tussock moth defoliation was recorded on a small isolated patch of Douglas-fir on the Flathead Indian Reservation, just south of Saint Ignatius. Approximately 412 acres of western spruce budworm defoliation was mapped from the air northwest of Helena. Scattered tent caterpillar damage was again seen in western Montana. One gypsy moth male was trapped south of Livingston. Defoliation of cottonwoods and willows by satin moth was observed in the Drummond to Phillipsburg area.

Mortality and growth losses from root disease continue to be high throughout the state. Root disease-caused mortality is more common west of the Continental Divide, although large patches can be found east of the Divide. The effect of the fires of 2000 on root diseases is one of opportunity. The tree species that are best adapted to low intensity, high frequency fires, are those species that are also root disease-tolerant, such as western larch and ponderosa pine. In the root diseased areas that burned, there is the opportunity to reduce the effects from root disease by planting these species or encouraging the natural regeneration of these species.

Dwarf mistletoe continues to cause losses of approximately 33 million cubic feet annually. Douglas-fir, western larch and lodgepole pine are the tree species most severely affected. Fire greatly influences the distribution of dwarf mistletoes across the landscape. In general, any fire event that kills infected trees will reduce the population of dwarf mistletoe, at least in the short term. Large, complete burns will greatly reduce dwarf mistletoe populations across the landscape and may even eliminate small, localized populations. Small, patchy burns will temporarily reduce the amount of mistletoe, but infected residuals provide a ready source of dwarf mistletoe seeds for the infection of the new regeneration.

White pine blister rust continues to be present throughout the range of five-needle pines in the state. Rust severity is highest in the northwestern part of the state where the disease continues to cause extensive mortality in western white pine.

Needle diseases continued to be heavy in localized areas. Elytroderma needle blight was heavy in ponderosa pine in localized areas across western and central Montana. Rhabdocline needle cast was detected in Douglas-fir in large areas across the state, on both sides of the Divide. Needle casts in pine in eastern Montana were also heavy in localized areas. Needle blight in limber pine was low this year, but needle cast showed a marked increase. Larch needle diseases were again low from the 1997 high levels.

ANNUAL AERIAL SURVEY

The annual aerial detection survey in Montana was conducted from July 5 until September 27, 2000. The limited survey was flown in approximately 213 hours and covered approximately 12.2 million acres of mixed ownership forestlands, excluding most wilderness areas, although portions of the Bob Marshall were flown. See Figure 1, Areas of 2000 coverage during the Forest Health Protection Aerial Detection Survey in Montana.

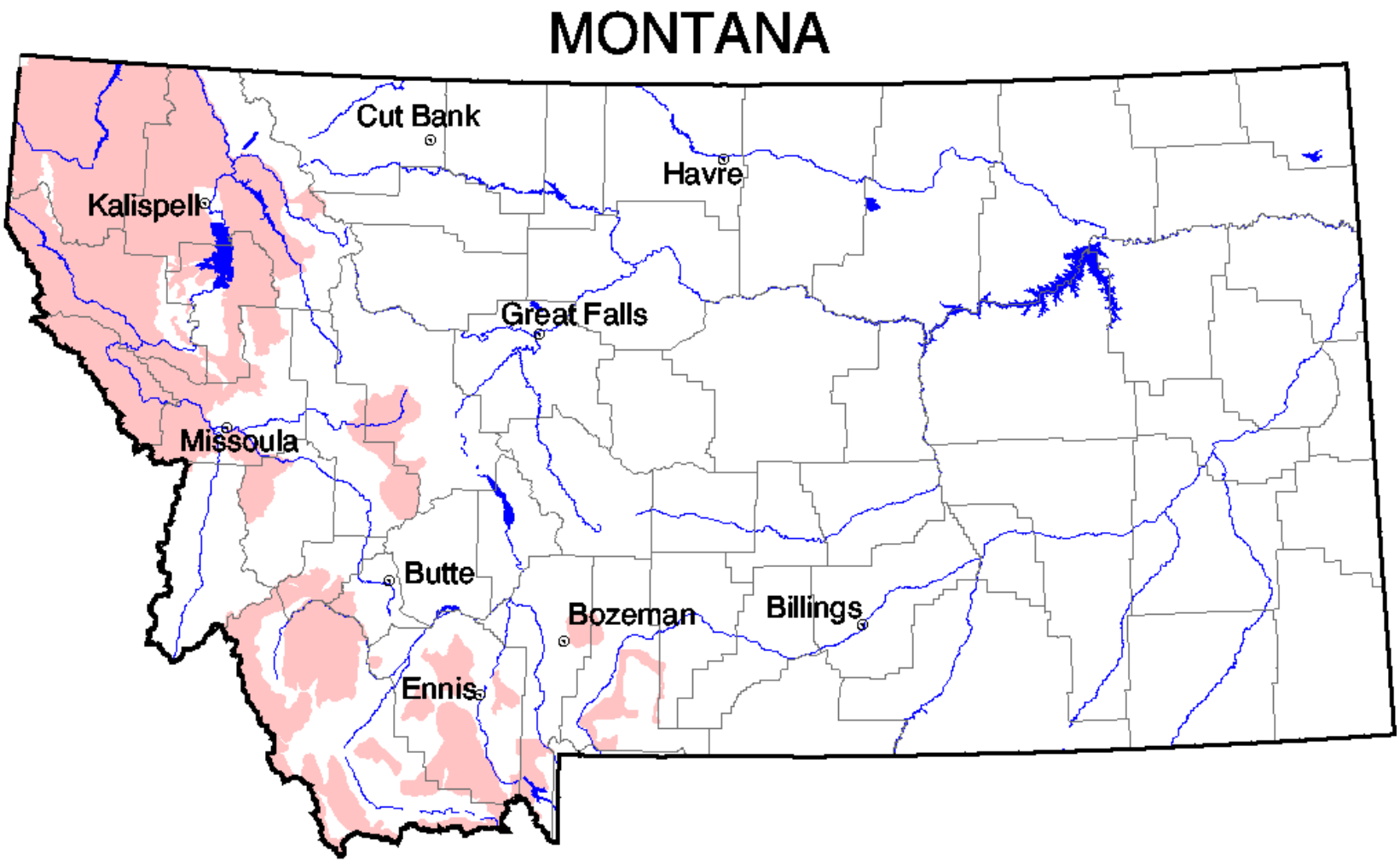
Three FHP sketch mappers, using three different airplanes, conducted the 2000 aerial survey. The survey was a shortened season due to extreme fire activity from late July into September. No survey flights were conducted from July 29 through September 10, 2000. Areas flown after those dates was later than normal, making for reduced visible discoloration and reduced good viewing light. Most of the Gallatin, Helena, and Garnet Reporting Areas were not flown. All of the Bitterroot, Deerlodge, Lewis and Clark and Custer Reporting Areas were not flown. All Indian Reservations in Montana were not flown, except the Flathead. Neither were Glacier or Yellowstone National Parks flown in 2000.

Much of the data summarized in this report is a product of the aerial survey, as well as ground surveys and biological evaluations. Along with the data summaries, aerial survey maps are available from the Missoula FHP Field Office, in both paper and digitized GIS format.

The annual aerial detection survey is an overview survey designed to cover large areas in relatively short periods of time. Aerially detected signatures include tree mortality, defoliation and windthrow. If forest disturbance activities are low, secondary disturbances such as diseases, needle casts, high-water damage and previous fire damage are sketch mapped. The intent of the survey is to cover each area once a year during which time the observer sketch maps as many disturbances and damage as possible. The survey is conducted using single-engine, high-wing airplanes, flying at speeds of approximately 90 to 130 M.P.H., at an average altitude of approximately 1,000 to 2,000 feet above ground level. The flight pattern is almost all contour, meaning following drainages rather than a straight-line grid pattern, while using one observer in each airplane.

The aerial survey data are estimates made from airplanes and though not as many areas were ground checked for accuracy, as we would like, enough were checked to lend confidence to the areas for which we only have aerial survey data. Together, aerial and ground surveys provide information relative to bark-beetle-caused mortality, as well as other damage agents, pertinent to land managers charged with the responsibility of maintaining forest health.

FIGURE 1. Aerial Survey Map



THE SUMMER OF 2000

The 2000 wildfire season in the State will be recorded as one of the more widespread and damaging in Montana's history. Slightly more than one million acres were burned to some extent in the Northern Region during the period July-October, 2000. Already, the fires of 2000 have been compared to the legendary ones of 1910. Though not as extensive, they were probably the most widespread since then. Management responses and weather will determine short- and long-term effects of the fires of 2000 on forest resources in general, and bark beetle populations in particular. Whatever those effects may be, however, fires in Montana had an immediate and decidedly deleterious effect on our efforts to record current status of bark beetle populations.

As a result, aerial survey data for 2000—as good as it was—was not directly comparable to that from previous years for some areas. In a few reporting areas, and for some bark beetles, aerial survey data suggested a reduction in beetle populations. In actuality, the opposite was true. In other areas, data for 2000 was missing all together. At the very least, compiled data for 2000, when compared to that for previous years, would need to include explanatory remarks indicating data may not have completely represented existing conditions in some areas.

While not all reporting areas in the State are flown every year, most are. A significant portion was not flown in 2000. Therefore, State data summaries may suggest a decline in beetle populations, when there was really only a decline in infested areas reported. An apparent "decline" in infested area may rather reflect nothing more than "missing" data. The following are areas for which no aerial survey data were acquired in 2000:

Forests:	Bitterroot, Custer, Deerlodge, Gallatin (Northwest), Helena (East), Lewis &Clark, Lolo (East, including Garnets [BLM])
Indian Reservations:	Blackfeet, Crow, Ft. Belknap, Northern Cheyenne, Rocky Boys, most of Nez Perce
Wilderness Areas:	Absaroka/Beartooth, Bob Marshall, Great Bear, Scapegoat
National Parks:	Glacier, Yellowstone

INSECTS

Bark Beetles

Abbreviations

The following abbreviations are used for beetles and their hosts throughout the bark beetle section:

Beetles	DFB	=	Douglas-fir beetle, *Dendroctonus pseudotsugae* Hopkins
	ESB	=	Spruce beetle, D. *rufipennis* (Kirby)
	IPS	=	Pine engraver, *Ips pini* (Say)
	MPB	=	Mountain pine beetle, *D*. *ponderosae* Hopkins
	WPB	=	Western pine beetle, *D*. *brevicomis* LeConte
	FE	=	Fir engraver, *Scolytus ventralis* LeConte
	WBBB	=	Western balsam bark beetle, *Dryocoetes confuses* Swaine
	RTB	=	Red turpentine beetle, *D*. *valens* LeConte
Hosts	LPP	=	Lodgepole pine
	PP	=	Ponderosa pine
	WWP	=	Western white pine
	WBP	=	Whitebark pine
	DF	=	Douglas-fir
	GF	=	Grand fir
	SAF	=	Subalpine fir
	ES	=	Engelmann spruce
Other	NF	=	National Forest
	RD	=	Ranger District
	IR	=	Indian Reservation
	BLM	=	Bureau of Land Management

CONDITIONS IN BRIEF

Douglas-fir Beetle (DFB): With the caveat that bark beetle damage estimates for 2000 are incomplete; we believe that, generally, DFB populations were reduced from 1999. Faded DF, those killed in 1999 or in some earlier cases, were still quite prevalent on the Kootenai and Lolo NFs. But with few exceptions (notable ones being on Fortine RD, Kootenai NF and Hebgen Lake RD, Gallatin NF), in areas ground surveyed, we found fewer attacks in 2000 than in 1999. While DFB populations were declining in most areas, the fires of 2000 could reverse that trend. A vast amount of fire-weakened DF—present on the Bitterroot, Helena, Lolo, and Kootenai NFs—may provide resources for a resurgence of DFB populations within the next 2-3 years**.**

Mountain Pine Beetle (MPB): MPB populations continued to increase in most areas surveyed. Extremely high populations exist, and increased, in LPP stands on the Lolo and Flathead NFs. Though aerial survey estimates for the Lolo NF showed a smaller infested area than recorded in 1999 (more than 49,000 acres in 1999; slightly less than 30,000 acres in 2000), ground surveys showed populations continued to increase in many areas. In many areas, especially on the Lolo and Flathead NFs, we anticipate beetle-caused mortality will continue to increase for at least a few more years. On the Custer, Lewis & Clark and portions of the Lolo NFs, serious MPB outbreaks existed in second-growth PP stands.

Western Balsam Bark Beetle (WBBB): WBBB populations likewise remained high in 2000. Many areas in which high populations have been recorded in the last few years were not flown in 2000. That being the case, direct comparisons of infested areas from 1999 to 2000 were not possible. Had all areas, which harbor WBBB populations, been flown, the infested area likely would have been higher in 2000.

Others: Other bark beetle species—spruce beetle (ESB), fir engraver (FE), western pine beetle (WPB), and pine engraver (IPS)—remained at relatively low to endemic levels. In some areas, minor amounts of mortality were caused by varying combinations of those sometimes-serious bark beetle pests. In most, however, populations are not causing significant management concerns. As noted for DFB, there may be some areas where beetles—notably ESB and WPB—may take advantage of fire-weakened hosts. Areas where those possibilities exist will need to be closely monitored for the next few years.

Table 1. Acres of host type infested by bark beetles, 1998-2000 (X 1000)

	1995	1996	1997	1998	1999	2000[1]
DFB	5,805	4,353	3,995	8,310	38,259	34,401
ESB	767	1,267	1,502	1,995	830	213
IPS	8,220	19	513	698	214	11
WPB	1,433	1,181	857	1,318	1,324	368
FE	349	401	615	523	134	159
WBBB	41,425	4,4673	30,088	59,248	43,472	28,010
MPB	31,340	27,503	34,187	39,198	77,347	40,758
Total	89,339	79,397	71,757	111,290	161,580	103,920

[1]Not all areas were flown in 2000 due to fires.

BARK BEETLE CONDITIONS BY REPORTING AREA

Beaverhead Reporting Area

Wisdom RD: Widely scattered, small groups (5-20 trees each) of WBBB-killed SAF were mapped north and west of the Big Hole Valley. Heaviest concentrations were recorded in upper elevations of Beaver Creek in the Anaconda-Pintler Wilderness. Mortality attributed to WBBB was also widely scattered in SAF stands southeast of the Big Hole, in the Beaverhead Mountains. SAF faders were more numerous and more widely found east of Big Hole Valley in the Pioneer Mountains.

Wise River RD: Occasional, widely scattered small groups of ESB-killed ES, DFB-killed DF and MPB-infested LPP were noted throughout the Pioneer Mountains on the District. Several small groups of DFB-caused mortality were found concentrated east of Grasshopper Creek drainage in Lake Creek and White Creek watersheds.

Dillon RD: Several small groups of SAF, killed by WBBB, were observed southwest of Clark Canyon Reservoir, near Maiden Peak, and along the Continental Divide, southwest of Monida Pass.

Madison RD: From Red Rock Lakes, throughout the Gravelly and Snowcrest Mountain Ranges north nearly to Virginia City, many large groups of WBBB-killed SAF, ranging in size from 5-tree groups to ones of more than 1,500 trees each, were observed. Though infested groups were extensive, they averaged only about 1-2 dead trees per acre.

In the Tobacco Root Mountains, many more groups of SAF faders were noted, but in that area, they were generally smaller than ones to the south. Many of those were concentrated from Mount Jackson, southeast to Baldy Mountain. A few widely scattered groups of SAF, killed by WBBB, were also observed in the Madison Range, north of Lone Mountain. DFB-killed DF were mapped in numerous small groups in the vicinity and east of Wade and Cliff Lakes, and in West Fork Madison River. In DF stands not far to the east, north of Earthquake Lake (Hebgen Lake RD, Gallatin NF), outbreak DFB populations have existed for a few years. They quite likely influenced DFB populations on the Madison RD.

BLM-Administered Lands: Numerous large groups of WBBB-killed SAF, up to 150 trees each, were noted in the Blacktail Mountains southeast of Dillon. In the Centennial Mountains, north of the Continental Divide, from West Fork Corral Creek to just east of Upper Red Rock Lake, even larger groups of beetle-infested SAF were noted. Many groups in the Centennial Mountains covered more than several hundred acres each.

Forest-wide, WBBB is by far the most significant mortality-causing agent. Nearly 18,700 acres were infested in 2000. The Forest was not flown in 1999, but in 1998 nearly 19,000 acres had been infested. Other forested areas harbored comparatively minor amounts of other bark beetle species, although DFB populations appeared to be increasing in some areas—a total of 770 acres were reported infested. ESB, IPS and MPB (in both LPP and WBP stands, 500 and 170 acres, respectively) were found at only widely scattered locations and mostly endemic levels.

Bitterroot Reporting Area

Because of extensive areas burned in the Bitterroot Valley and surrounding areas, the Bitterroot Reporting Area was not flown in 2000. In 1999, more than 13,600 acres were infested by DFB, and an estimated 61,000 DF had been killed. Another 2,500 PP, on approximately 2,000 acres, had been killed by MPB.

In spring 2000, in an effort to assess its effectiveness as an individual-tree protectant, we conducted a test of the DFB anti-aggregant, MCH (methylcyclo-hexanone), in an old-growth DF stand in Hughes Creek drainage, West Fork

RD. Sixty large-diameter DF were "baited" with a DFB attractant. To half of them we applied MCH bubble capsules. Beetle populations had declined more than anticipated and none of the 60 trees were attacked. Post-treatment data suggested beetle populations had been declining in that area, and perhaps Forest-wide, in 1999.

The Bitterroot Valley was the site of some of the more extensive and damaging wildfires in the Region in 2000. The Valley Complex, Skalkaho, Wilderness and Blodgett fires burned in excess of 350,000 acres, on lands of various ownerships. Many were in mixed species stands, some dominated by DF. Because many stands burned with varying intensities, we believe there is a potential for DFB populations to rebuild to outbreak levels within the next year or two. PP stands may likewise harbor damaging populations of IPS, WPB, or MPB. As restoration projects of several types are undertaken, the likelihood of increasing beetle populations will have to be considered.

Custer Reporting Area

The Custer Reporting Area was not flown in 2000. In 1999, approximately 450 acres of MPB-infested PP had been recorded. Another 12 acres had shown noticeable amounts of IPS activity. The Sixmile fire burned in an area not far from lands administered by Ashland RD. Bark beetle activity could increase in response to the presence of fire-weakened trees.

Deerlodge Reporting Area

The Deerlodge Reporting Area was not flown in 2000. LPP stands south, east and northwest of Butte, however, were known to contain significant MPB populations. In 1999, nearly 1,000 LPP were killed on about 250 acres. Ground surveys conducted in fall 2000 confirmed those populations continued to increase.

Flathead Reporting Area

Swan Lake RD: Many scattered groups of DFB-killed DF were mapped from Holland Lake and Lindberg Lake, north throughout Swan Valley. Most were on the Valley's east side, east of Swan Lake to Weed Lake. Highest concentrations were noted around Holland and Lindberg Lakes, but DFB-affected groups were also quite numerous throughout the Swan River drainage.

Also in that general area, on the east side of Swan Valley, widely scattered small groups of WWP killed by MPB and SAF infested by WBBB were observed. West of Swan Valley, in the northern portion of the Mission Range, many small groups of MPB-killed WWP and WBBB-impacted SAF were also noted. A few DFB-infested DF were observed in that area as well.

In the Moore Creek and Cedar Creek drainages, east of Moore and Cedar Lakes, several groups of LPP were seen which had been killed by MPB. Many small groups of DFB-killed DF were found west of Swan Lake**,** between Swan Lake and Flathead Lake.

On the "Island Unit," mostly west of Blacktail Mountain, several widely scattered groups of DFB- and WBBB-killed trees were mapped. In addition, a few small groups of PP which had been killed by WPB were observed.

Tally Lake RD: Many small groups of DFB-killed DF, 5-50 trees each, and a few larger ones, up to 300 trees each, were mapped generally west of Tally Lake. Most of those were concentrated in Logan Creek and Griffin Creek drainages. DFB-caused mortality was more widely scattered from there south to just below Ashley Lake.

On the District's western edge, from just south of Grubb Mountain and north to Elk Mountain, several large groups of SAF killed by WBBB were mapped. Many of those were concentrated near Sheppard Mountain.

Only minor amounts of other bark beetle-caused mortality—such as LPP and WWP, killed by MPB, and endemic amounts of ESB-killed ES—were found, and those were widely scattered throughout the District.

Glacier View RD and Stillwater SF: Widely scattered small groups of WBBB-killed SAF and MPB-killed WWP were noted in the Stillwater

River drainage on the western slopes of Whitefish Range—lands administered by Stillwater State Forest. On eastern slopes of the Whitefish Mountains, and westward to North Fork Flathead River, many but mostly small and widely scattered groups of DF, killed by DFB, and WBBB-infested SAF were mapped from Whale Creek on the north and south to Spoon Lake.

Heaviest concentrations of WBBB-caused mortality were located in Hay Creek drainage, with most DFB-caused damage found in Coal Creek and Big Creek drainages. More numerous groups of trees killed by both beetles were observed in the lower portion of Swift Creek drainage, north of Whitefish Lake.

Hungry Horse/Spotted Bear RDs: Several small groups of DF, killed by DFB, were noted on Coram Experimental Forest, east of Coram, though those infestations were much reduced from a few years ago. DFB-caused mortality was more widely scattered along both sides of Hungry Horse Reservoir, with concentrations of beetle-killed DF located in Aeneas Creek, Bigelow Creek, Quintonkin Creek, and Sullivan Creek drainages on the west side of the Reservoir. To the east of the Reservoir and into tributaries of Middle Fork Flathead River, DFB-killed trees were especially noticeable in Essex Creek, Sheep Creek, and Java Creek drainages.

Also noted along both sides of the Reservoir, but more heavily concentrated on the east side; were numerous, small groups of WWP killed by MPB. Near Spotted Bear, in the Spotted Bear River drainage, quite a few small groups of DF, infested by DFB, were mapped. More significant amounts were noticed in Bent Creek and Trail Creek drainages. Fewer, but noticeable groups WBBB-killed SAF were mapped northeast of Big Bill Mountain.

The most beetle-caused mortality on either District, however, is caused by MPB in LPP stands, south and east of Spotted Bear RS. In that area, many small groups of up to 100 trees each, plus numerous larger ones of up to 5,000 trees each were recorded. Those infested areas have increased in both area and number of trees killed since for the past several years. In addition, but of much less significance, minor amounts of ESB-killed ES and WBP killed by MPB, were noted in that general area.

Forest-wide, in 1999, about 16,000 DF had been killed by DFB on 4,200 acres; and approximately 23,000 LPP had been killed by MPB on another 4,000 acres. For 2000, respective mortality estimates were 14,200 DFB-killed DF on 6,300 acres, and 24,300 MPB-infested LPP on 4,720 acres.

Gallatin Reporting Area

Big Timber RD: While only about half of the Gallatin reporting area was flown in 2000, part of that was the Boulder River drainage. There, DFB-killed DF were noted in numerous scattered groups throughout much of the drainage. The more significant groups were mapped from War Eagle Mountain, north to Clear Creek. Within the past few years, the use of DFB-pheromone tree baits and pheromone-baited funnel traps, in conjunction with other management activities, have helped reduce beetle-caused mortality in the Boulder River corridor.

A few small groups of WBBB-infested SAF and MPB-killed WBP were also observed in stands occupying upper portions of Boulder River.

Livingston RD: Flights over the southern portion of the District showed still active DFB populations in Mill Creek drainage where several small groups of DF faders were observed. These appeared to be remnants of an outbreak which has existed in that area for more than 10 years. Though still present, beetle-killed groups of trees were mostly small, 5-20 trees each, and widely scattered.

In tributaries of upper Mill Creek, Lambert Creek and Colley Creek, several small groups of WBBB-killed SAF were also noted.

Gardiner RD: Numerous small and widely scattered groups of DFB- and WBBB-caused mortality were mapped north and east of Gardiner and in the vicinity of Jardine.

Hebgen Lake RD**:** Many small groups of beetle-killed DF and SAF were found scattered throughout the District, from the Montana/Idaho border north to Buck Creek. From there north, the remainder of the Madison Range was not flown. In 1999, more that 37,000 acres in that general area contained some level of WBBB-caused mortality. We assumed much of that area still contained active beetle populations. Portions of the District which were flown showed DFB-killed DF concentrated in small—5-40 tree groups—near Hebgen Lake and north of Earthquake Lake.

In the Watkins Creek drainage, pheromone-baited funnel traps were hung in several areas in order to reduce beetle-caused mortality to some extent in spring 2000. We found several beetle-attacked trees near trap sites, and in a few previously uninfested stands in the upper part of the drainage. In the general areas where traps were installed, there appeared to be a general reduction in DFB population.

Heavier concentrations of WBBB-caused mortality were also mapped in upper Watkins Creek and Kirkwood Creek drainages and WBBB-killed trees were numerous from there northward for several miles.

Bozeman RD: A portion of the Bridger Mountain Range was surveyed in 2000. Widely scattered small groups of DFB-killed DF were mapped in and around Bridger Bowl ski area. Ski area managers have been aggressively salvaging beetle-infested trees. Those activities have helped prevent more rapid beetle population expansion in that area. The remainder of the District was not flown.

Forest-wide, beetle-killed tree estimates for 1999 showed 47,000 SAF killed by WBBB on 37,600 acres; another 2,900 DFB-killed on about 1,200 acres. Aerial survey estimates for 2000 indicated mortality had declined to slightly less than 7,000 acres infested by WBBB; however, much of the previously infested areas in the Madison Range was not flown. Another 1,250 acres were infested by DFB. Approximately 3,100 SAF and 3,600 DF were killed in 1999 and recorded as faders in 2000.

Helena Reporting Area

Lincoln RD: Only the western portion of the Helena NF was surveyed in 2000. In that area, numerous small groups of DFB-killed trees were mapped northwest of Lincoln in Arastra Creek drainage. Others were observed south of there in Moose Creek and Little Moose Creek drainages above the Blackfoot River. A few other widely scattered groups of DF faders were noted northeast of Nevada-Ogden Road, north of Avon Valley, and in General Robert E. Lee Mountain Range, along Poorman Cr and its tributaries. Several groups of WBBB-affected trees were found near Stonewall Mountain.

A few small and widely scattered groups of MPB- or WPB-killed PP were noted within a several-mile radius of Lincoln. Another few small groups of beetle-infested PP were mapped in the McKay Creek drainage east of Antelope Hill.

The eastern half of the Forest was not flown in 2000; however, in 1999 several areas east of Helena were recorded as containing significant amounts of beetle-caused mortality—notably MPB in PP stands and DF killed by DFB.

Whereas DFB had killed an estimated 1,000 DF on 600 acres, and MPB had killed 1,500 PP on 700 acres in 1999; comparable figures had declined to about 740 beetle-killed DF on more than 270 acres and approximately 320 MPB- or WPB-infested PP on 140 acres in 2000. Another 140 SAF were reported killed by WBBB on about 75 acres. These apparently declining trends may be due to fewer acres surveyed.

Kootenai Reporting Area

Cabinet RD: DFB remained the most significant bark beetle pest on the Forest, though generally populations and infested areas have declined since 1999. Still, numerous groups of beetle-killed trees were found on most Districts. Cabinet RD was the most severely impacted with heavy concentrations of DFB-killed groups found in Vermillion Creek, Beaver Creek, Pilgrim Creek, Elk Creek, Rock Creek, and Government Creek drainages; and throughout the Bull River

drainage and its tributaries from Clark Fork River to Bull Lake. While most groups ranged from 5-50 trees, several were as large as 200-1000 trees each. In other parts of the District, DFB-killed trees were scattered throughout DF forest types.

Three Rivers RD: From Bull Lake north to Pine Creek and into the lower Yaak River drainage, DFB-killed groups were numerous and widely scattered. A considerable number of groups were also found along O'Brien Creek and east along the Kootenai River.

A declining, but still active outbreak of MPB was mapped in LPP near Newton Mountain. Widely scattered SAF, killed by WBBB, and MPB-infested WWP were also found in upper Yaak River drainage.

Libby/Canoe Gulch RD: DFB outbreaks on the District extended from Big Hoodoo Mountain, southwest of Libby and to Fisher River on the south; north to the Libby/Rexford RD boundary on the west side of Lake Koocanusa. Groups of beetle-killed trees were particularly numerous to the northeast and southeast of Libby—as far east as Brush Creek and Lemonade Spring.

Rexford RD: DFB-killed groups of DF were frequent along Pinkham Creek and its tributaries. In addition, small concentrations of WBBB-killed SAF were mapped in the Salish Mountains, east of Lake Koocanusa, in a few high-elevation stands. Those outbreaks are nearly insignificant when compared to amount of DFB-affected stands, however.

Fortine RD: DFB-killed DF were prevalent in Sunday Creek drainage and north along Gibralter Ridge; and also the Galton Range, north to the Canadian border. The latter area was one of the few in the Region where DFB populations increased in 2000. Pheromone-baited funnel traps were hung at two sites on the District—Burma Creek and Indian Creek. An estimated 95,000 DFB were collected, but still-increasing beetle populations suggested trapping may again be beneficial in 2001. Few other bark beetles were as important District-wide; however, significant amounts of WBBB—infested SAF were observed in upper Sunday Creek drainage.

Total DFB-caused mortality on the Forest was estimated to be nearly 60,000 trees on 19,800 acres in 1999. Current estimates showed slightly fewer than 43,000 DF killed on 15,500 acres in 2000. Other bark beetle-infested stands were less frequently encountered, although approximately 2,100 SAF have been killed by WBBB on almost 2,000 widely scattered acres. Because of extensive areas burned in the Kootenai Complex, Stone-Young, and other fires in 2000, there is a high likelihood for DFB populations to increase—as they did after the series of fires on the Forest in 1994.

Lewis & Clark Reporting Area

The Lewis & Clark Reporting Area was not flown in 2000. In 1999, extensive outbreaks of WBBB in SAF stands had been reported on the Musselshell RD. There were also notable amounts of MPB-caused mortality in both LPP and PP stands at various locations on the Forest. Forest-wide, more than 1,700 PP and nearly 800 LPP had been killed on about 1,500 and 600 acres, respectively. Approximately 4,500 SAF were killed on 2,700 acres. The Maudlow/Toston fire complex burned over lands not far from ones administered by the Forest. Bark beetle responses to fire-affected stands could influence management decisions in the near future.

Lolo Reporting Area

Missoula RD: Many groups of DFB-killed trees were recorded in Sapphire Mountains, and especially Rock Creek drainage, southeast of Missoula. Heaviest concentrations of beetle-killed trees were mapped in Alder Creek, Cinnabar Creek, Albert Creek, Ranch Creel, and Brewster Creek drainages, and in Kitchen Gulch. DFB-killed groups generally ranged from 5-90 trees each.

In upper elevations of Rock Creek drainage, a few groups of SAF, killed by WBBB, were mapped; and at lower elevations, along Clark Fork River, a few MPB- and WPB-killed PP were noted.

West of Missoula, many widely scattered groups of DFB-caused mortality were observed in Petty Creek and Lolo Creek drainages, and

more generally throughout the Grave Creek Range. A few PP killed by MPB and WPB were also observed in lower elevation stands west of Missoula.

Ninemile RD: Widely scattered DF, killed by DFB, were noted in Fish Creek drainage and smaller tributaries of Clark Fork River, west nearly to Superior. Throughout Ninemile Creek drainage, there were scattered DFB-killed DF and MPB-killed PP; however, the most significant mortality agent on the District is MPB in LPP stands.

Several large groups of MPB-killed LPP, of up to 500 trees each, were mapped in Mill Creek drainage north of Frenchtown; and there were widely scattered groups found from there west to Siegel Pass. The largest groups of MPB-killed LPP on the District, in the last 2-3 years, have been found in the vicinity of Siegel Mountain. Though somewhat less in both extent and intensity in 2000 than in 1999, thousands of LPP were killed near there in the past year. The largest polygon was estimated to contain 25,000 dead trees; others contain several thousand each. That general area was also the site of one of the major fire complexes, the Ninemile Complex, in 2000. For the next several years, there will be a combination of mortality factors—fire effects and bark beetles—killing trees in those mixed-species stands.

Superior RD: DFB-killed trees were still widely observed throughout the District, particularly in tributaries of Clark Fork River and much of the St. Regis River drainage. DF stands both north and south of Superior were heavily infested.

MPB in LPP caused most bark beetle-related mortality on the District, however. From Keystone Ridge, westward along “CC Divide” and nearly to Montana/Idaho border, many LPP stands have been severely impacted by MPB. Most seriously affected areas were near Camels Hump, in upper Blackburn Creek and Twelvemile Creek drainages, and around Knox Pass. Ground-collected data from stands near Greenwood Hill and Knox Pass showed more than 57 and 72 LPP/acre, respectively, killed in 2000. Another data set, collected by personnel from RMRS, in Logan, UT in that general area showed 17 LPP per acre killed in 2000, 27 in 1999, 84 older dead, and an estimated 99 trees per acre may yet be killed within the next few years.

Plains/Thompson Falls RD: Although many DF have been killed by DFB in the past few years; MPB-caused mortality in LPP stands remained the most widespread condition affecting management decisions on the District. DFB-killed DF were recorded throughout Thompson River drainage, both north and south of Thompson Falls, and in many parts of Prospect Creek drainage.

MPB-killed LPP were mapped in many large groups, from west of Siegel Pass throughout Coeur d’Alene Mountains, and west to Dry Creek. Largest groups were mapped near Siegel Pass, Patricks Knob, Greenwood Hill, in upper Cherry Creek, near Eddy Mountain, and north of Knox Pass. Elsewhere on the District, minor amounts of WBBB-caused mortality were mapped in high-elevation SAF stands.

Forest-wide, in 1999 more than 477,500 LPP were killed on 47,400 acres—average 10.1 trees per acre. In 2000, comparable figures were 216,500 LPP killed on 28,200 acres; averaging about 8 trees per acre. An additional 2,250 PP were killed on 1,600 acres. Most MPB-caused mortality was recorded on Superior, Plains/Thompson Falls, and Ninemile RDs. Though a decline in infested area was suggested from aerial survey estimates; ground collected-data suggested outbreaks were still increasing. We anticipate that will be the case for the next several years—until many of the larger, older LPP in those stands have been killed.

INDIAN RESERVATIONS

Flathead IR

While not all of the Reservation was flown in 2000, parts that were showed still significant bark beetle outbreaks in some areas. In the southeastern corner, many small groups of MPB-killed LPP were recorded in the Jocko

River drainage—especially noticeable in the Pistol Creek area.

Also in the Jocko drainage were many DFB-killed groups of DF. At lower elevations, MPB-killed PP was mapped. From there north to the Reservation boundary, along western slopes of the Mission Mountains, many widely scattered groups of DF, killed by DFB, were recorded. Scattered throughout lower-elevation PP stands in that area as well, many small groups of MPB-killed trees were noted.

East of Skidoo Bay several groups of LPP, killed by MPB, were recorded—some as large as 300 trees each. Throughout the northern portion of the Reservation, from eastern shore of Flathead Lake to Bassoo Peak on the west, widely scattered, small groups of MPB-killed PP and LPP were recorded. Southward, along the Reservation's western boundary, scattered groups of LPP, killed by MPB, were mapped—the most numerous being in the vicinity of Rainbow Lake. South of there, in Clear Creek drainage, numerous groups of MPB-killed PP were observed.

Eastward, from Sonyok Mountain north to Whiskey Gulch, several groups of PP, and fewer LPP, were killed by MPB. From Perma, southeastward to Evaro, numerous small groups of PP killed by MPB were recorded. At some of the higher elevations in that area, MPB had killed a smaller number of LPP. In total, MPB killed 5,200 LPP and 3,400 PP on a combined 3,930 acres in 1999. Those were recorded as faded trees in 2000. Another 2,200 DF, on 770 acres, were killed by DFB.

Others

None of the other Montana Indian Reservations were flown in 2000. There were, however, important bark beetle infestations reported on some of them in 1999. On Crow and Northern Cheyenne Reservations in southeastern Montana, MPB and IPS have killed significant amounts of PP within the past few years. Last year, on Crow IR, about 1,400 acres of second-growth PP were infested and bark beetles killed an average 2 trees per acre. On Northern Cheyenne IR, about 1,500 PP were killed on 600 acres.

In the north-central part of the State, on Rocky Boys and Ft**.** Belknap IRs, both MPB in LPP and PP stands, and DFB in DF stands have caused mortality serious enough to be a management concern. Those populations should be monitored in 2001.

NATIONAL PARKS

Neither Glacier nor Yellowstone NPs were flown in 2000, with the exception of a small strip on the southern border of Glacier NP, along Middle Fork Flathead River. Bark beetle populations of varying extents were known to exist in both, however. In 1999, DFB populations were recorded in the northern part of Glacier NP, around Logging, Quartz, Bowman, and Kintla Lakes. In the southern portion, minor amounts of ESB-caused mortality had been observed. In 1997, the last year Yellowstone NP was flown, significant amounts of WBBB, DFB, and ESB-caused mortality had been recorded. No doubt, some of those populations still existed in 2000.

TABLE 2. Douglas-fir beetle-infested acres and new dead trees in Montana, all ownerships, from 1997 through 2000

	1997		1998		1999		2000	
Reporting Area	**Acres**	**Trees**	**Acres**	**Trees**	**Acres**	**Trees**	**Acres**	**Trees**
Beaverhead NF	104	118	95	146	★	★	772	1,716
Bitterroot NF	102	292	358	800	1,163	4,619	★	★
Custer NF	60	162	27	60	0	0	★	★
Deerlodge NF	51	148	319	523	825	1,858	★	★
Flathead NF	531	1,264	796	2,093	4,237	15,891	6,329	14,199
Gallatin NF	212	602	750	1,782	1,234	2,896	*12,44	3,600
Helena NF	269	649	241	530	584	1,037	*273	740
Kootenai NF	390	765	2284	8,475	19,858	59,902	15,352	42,677
Lewis & Clark NF	213	310	190	276	373	621	★	★
Lolo NF	1,066	1,942	2332	6,305	9,495	32,890	9660	28,296
Garnets	86	141	257	674	417	1,333	★	★
Flathead IR	183	317	152	265	164	547	771	2,258
Crow IR	4	5	★	★	★	★	★	★
Glacier NP	136	362	492	1726	*57	146	★	★
Yellowstone NP	537	1,577	★	★	★	★	★	★
Other	10	9	16	36	33	50	★	★
TOTAL	3,954	8,663	8,309	23,691	38,440	121,790	34,401	93,486

★ = Not surveyed

*Only partially surveyed

TABLE 3. Acres of mountain-pine-beetle-caused mortality on State and private lands in Montana from 1997 through 2000

	1997				1998				1999				2000			
Reporting Area	LPP[1]	PP	WBP	WWP	LPP	PP	WBP	WWP	LPP	PP	WBP	WWP	LPP	PP	WBP	WWP
Beaverhead NF	4		0	0	38	2	4	0	★	★	★	★	35	6	12	
Bitterroot NF	0	1,827	0	0	4	824	0	0	0	882	0	0	★	★	★	★
Custer NF	6	77	0	0	4		0	0	0	33	0	0	★	★	★	★
Deerlodge NF	26	12	0	0	120	115	0	0	47	26	0	0	★	★	★	★
Flathead NF	46	97	0	158	142	41	2	944	57	90	12	13	81	46	0	107
Gallatin NF	517	34	10	0	178	4	10	0	69	6	118	0	*	*	4	0*
Helena NF	73	312	12	0	21	225	8	0	119	449	12	0	2	94	20	0*
Kootenai NF	72	16	2	51	56	31	0	33	15	117	0	63	14	25	0	14
Lewis & Clark NF	147	3,047	0	0	68	384	0	0	122	827	5	0	★	★	★	★
Lolo NF	2,008	1,126	13	19	2,040	1,101	0	0	1,819	368	3	7	992	172	0	2
Garnets	22	629	0	0	22	314	0	0	20	1,325	0	0	★	★	★	★
Crow IR	0	4	0	0	★	★	★	★	★	664	0	0	★	★	★	★
Fort Belknap IR	0	169	0	0	3	338	0	0	0	113	311	0	★	★	★	★
No. Cheyenne IR	0	4	0	0	★	★	★	★	0	4	0	0	★	★	★	★
Rocky Boy IR	142	22	0	0	198	20	★0	0	6	336	0	0	★	★	★	★
Flathead IR	29	124	0	0	53	146	0	0	72	0	0	0	135	624	28	0
Other	0	0	0	2	0	0	0	0	0	0	0	0				2
Total	3,092	7,500	37	230	2,947	3,545	24	977	2,346	5,240	461	83	1,259	967	64	125

[1]LPP = Lodgpole pine; PP = ponderosa pine; WBP = whitebark pine; WWP = western white pine
★= Not flown
* = Partially flown

TABLE 4. Acres of mountain-pine-beetle-caused mortality on Federal ownership in Montana from 1997 through 2000

	1997				1998				1999				2000			
Reporting Area	LPP[1]	PP	WBP	WWP	LPP	PP	WBP	WWP	LPP	PP	WBP	WWP	LPP	PP	WBP	LPP
Beaverhead NF	125	4	10	0	486	4	31	0	★	★	★	★	641			
Bitterroot NF	18	463	0	0	63	358	2	0	34	978	10	0	★	★	★	★
Custer NF	60	447	9	0	0	0	0	0	0	416	0	0	★	★	★	★
Deerlodge NF	86	14	6	0	350	66	4	0	203	31	6	0	★	★	★	★
Flathead NF	793	24	26	213	1,461	8	32	242	3,936	75	28	64	4,639	100	42	447
Gallatin NF	304	24	85	0	119	0	314	0	133	0	7,684	0	6	*	14	*
Helena NF	144	160	54	0	78	307	30	0	294	232	30	0	8	8	2	0*
Kootenai NF	663	42	4	429	1,087	74	4	506	83	252	4	834	190	98	0	199
Lewis & Clark NF	443	1,047	6	0	259	526	4	0	451	724	571	0	★	★	★	★
Lolo NF	12,766	1,525	34	219	20,087	1,139	8	88	45,558	1,234	61	102	27,217	1,436	10	56
Crow IR	6	8	0	0	★	★	★	★	0	732	0	0	★	★	★	★
Fort Belknap IR	107	1,129	0	0	98	1,861	0	0	60	753	0	0	★	★	★	★
Flathead IR	693	306	0	0	1,011	144	0	0	2,005	825	2	0	1,467	1,810	0	0
No. Cheyenne IR		587	0	0	★	★	★	★	0	582	0	0	★	★	★	★
Rocky Boy IR	60	60	0	0	132	88	0	0	30	174	0	0	★	★	★	★
BLM (Garnets)	6	47	2	0	8	27	0	0	10	16	0	0	★	★	★	★
Glacier NP	14	0	0	16	6	0	0	47	0	0	0	0	6	*	*	12
Yellowstone NP	20	0	22	0	★	★	★	★	0	0	0	0	★	★	★	★
Total	3,092	7,500	37	230	2,947	3,545	24	977	2,346	5,240	461	83	34,174	3,498	237	714

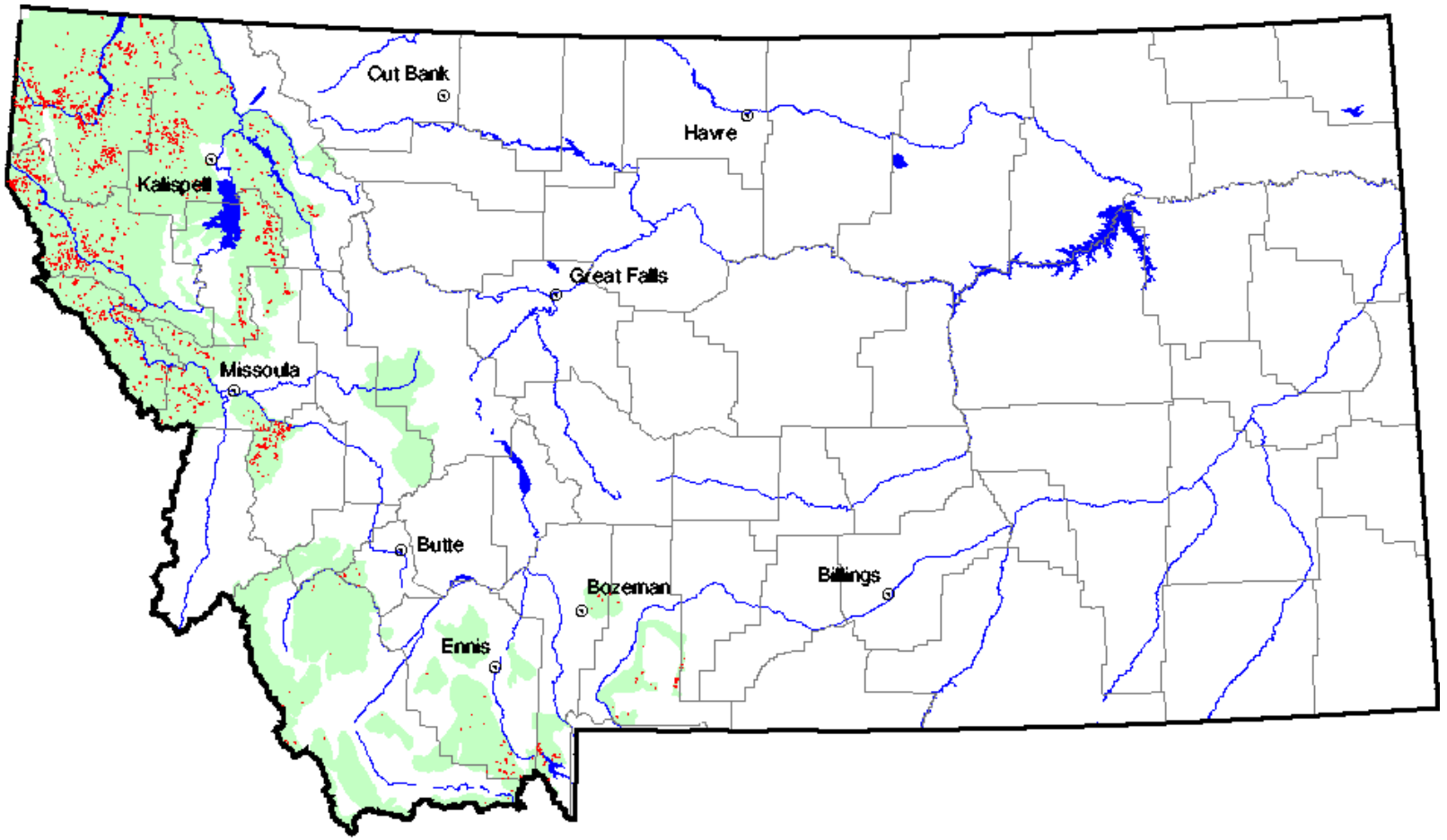
[1]LPP = Lodgepole pine; PP = ponderosa pine; WBP = Whitebark pine; WWP = western white pine
★ = Not flown
* = Partially flown

TABLE 5. Bark-beetle-infested acres (other than mountain pine beetle and Douglas-fir beetle) in Montana, all ownerships

	Engelmann Spruce Beetle				Pine Engraver Beetle				Western Pine Beetle				Fir Engraver Beetle				Western Balsam Bark Beetle			
Reporting Area	**1997**	**1998**	**1999**	**2000**	**1997**	**1998**	**1999**	**2000**	**1997**	**1998**	**1999**	**2000**	**1997**	**1998**	**1999**	**2000**	**1997**	**1998**	**1999**	**2000**
Beaverhead NF	14	0	★	6	156	382	★	0	118	0	★	—	0	0	★	0	6,081[1]	18,612	★	18,698
Bitterroot NF	6	16	12	★	0	2	6	★	0	172	134	★	0	4	0	★	12	59	119	★
Custer NF	0	0	0	★	33	0	12	★	0	0	0	★	0	0	0	★	434	37	0	★
Deerlodge NF	3	2	2	★	0	134	74	★	8	28	0	★	0	4	0	★	61	99	291	★
Flathead NF	537	878	304	118	2	0	0	2	38	72	43	64	92	111	79	56	765	760	0	3,407
Gallatin NF	299	2	244	*53	60	0	0	*0	0	0	0	*0	0	0	0	*0	21,251	38,806	37,588	*3,123
Helena NF	8	4	22	*0	0	2	2	*0	106	0	2	*36	0	0	0	*0	111	65	89	*78
Kootenai NF	115	59	82	8	0	4	14	2	91	224	103	66	289	120	6	26	123	287	718	1,978
Lewis & Clark NF	2	2	45	★	32	36	0	★	0	0	0	★	0	0	0	★	430	241	2,671	★
Lolo NF	38	34	40	14	157	22	22	0	314	432	893	190	215	253	31	22	161	168	1,019	300
Garnets	0	2	0	★	0	3	0	★	45	58	91	★	0	0	2	★	12	2	26	★
Flathead IR	2	4	0	2	6	113	8	7	136	161	59	10	18	26	16	55	13	99	38	72
No. Cheyenne IR	0	★	4	★	65	★	74	★	0	★	0	★	0	★	0	★	0	★	0	★
Fort Belknap IR	0	0	0	★	2	0	0	★	0	0	0	★	0	0	0	★	0	0	0	★
Rocky Boy IR	0	0	0	★	0	0	0	★	0	0	0	★	0	0	0	★	0	0	0	★
Crow IR	0	★	0	★	0	★	0	★	0	★	0	★	0	★	0	★	0	★	0	★
Glacier NP	342	991	37	★	0	0	0	★	2	0	0	★	2	0	0	★	0	14	8	★
Yellowstone NP	136	★	0	★	0	★	0	★	0	★	0	★	0	★	0	★	634	★	0	★
Total	1,502	1,994	792	201	513	698	212	11	858	1,147	1,325	366	614	518	134	159	30,088	59,249	42,567	27,565

[1] = Only a portion of the Beaverhead NF was flown in 1997
★ = Not flown
* = Partially flown

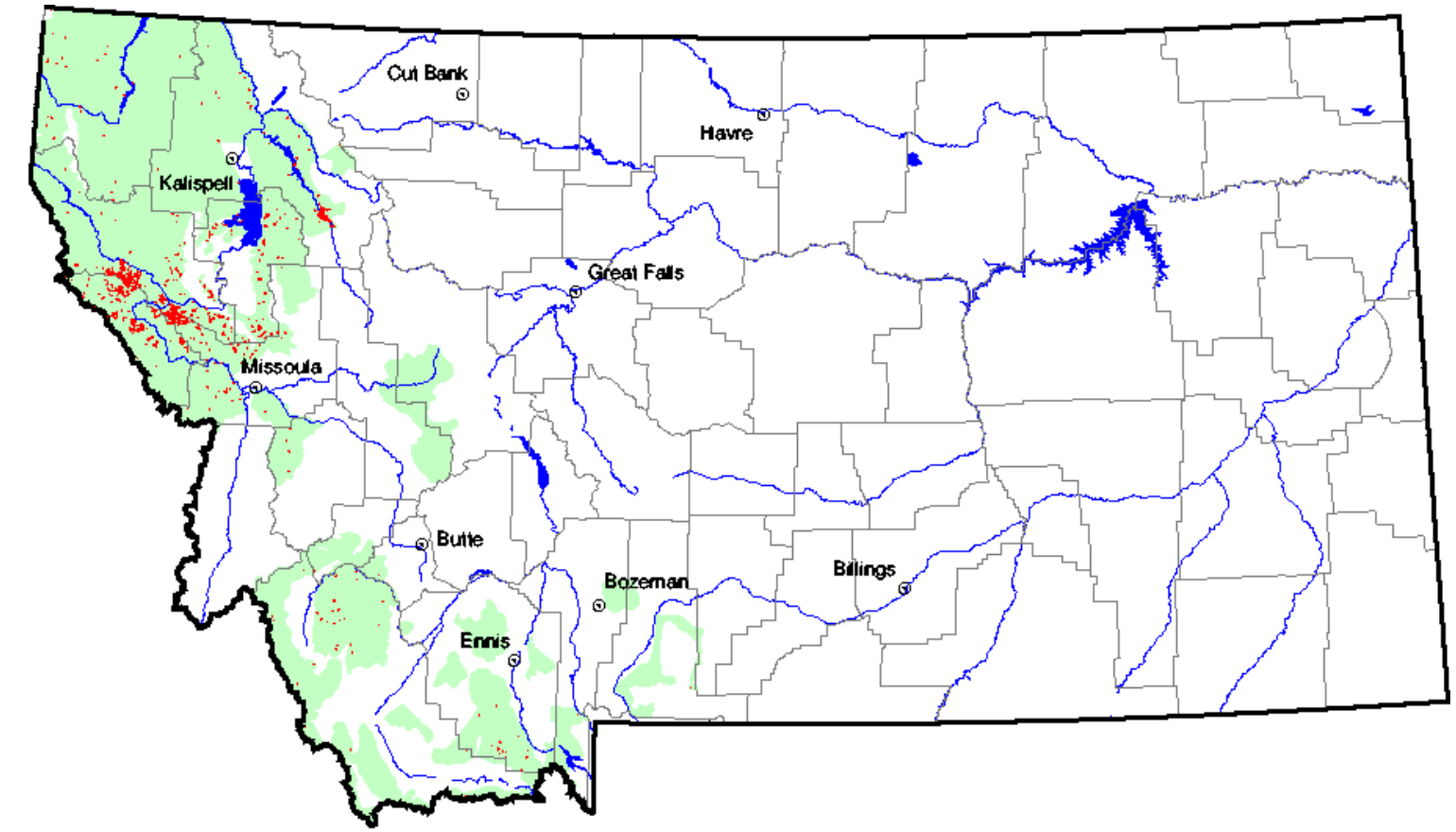
FIGURE 2. Douglas-fir beetle



Areas of Douglas-fir Beetle infestations in Montana, 2000.

Area Surveyed in 2000

FIGURE 3. Mountain pine beetle



DEFOLIATORS

Western Spruce Budworm

Defoliation from western spruce budworm was detected on 411 acres northwest of Helena on Bureau of Land Management, private and Forest Service land, during the 2000 aerial survey. A small amount of defoliation was detected in the same area during the 1998 aerial survey, but none was found in 1999. Pheromone trap counts increased in 2000 at all locations that were trapped. Trap catches on the Helena NF and the Lubrecht Experimental Forest increased to 164 moths in 2000, up from 107 in 1999. Two budworm permanent plot sites on the Deerlodge NF, were trapped in 2000, Moffet Mountain and State Mine Park. Moffet Mountain trap counts increased from 64 moths in 1999 to 230 moths in 2000. Trap catches at State Mine Park increased from 2 moths in 1999 to 42 moths in 2000.

Steadily increasing pheromone trap catches may signify the beginning of a budworm outbreak cycle especially if the relatively mild winters and warm and dry summers continue which favor budworm population growth. An increase in the number of acres defoliated and the intensity of defoliation on some eastside forests is expected in 2001.

Larch Casebearer

In 2000**,** visible defoliation caused by casebearer (LCB) decreased in most previously defoliated larch stands in western Montana. Moderate defoliation was seen along the Bull River for several miles between US Highway 200 to north of Bull Lake.

Douglas-fir Tussock Moth

In 2000, extremely heavy Douglas-fir tussock moth defoliation was observed in July in two distinct stands of predominantly Douglas-fir totaling approximately 35 acres. The stands were located on the southern portion of the Flathead Indian Reservation northeast of Ravalli, just south of the rest area at the top of Ravalli Hill. Considerable tree mortality in the defoliated areas has occurred.

Monitoring of Douglas-fir tussock moth population levels by means of pheromone-baited sticky traps to catch adult males has been done in western Montana since 1979. Traps have been placed at 33 permanent plots. The nearest plot to the defoliated area was on the Pistol Creek road; about 3 miles to the northwest, where trap catches in 1999 averaged 63.6 moths per trap. Because of the high trap catches, lower crown larval samples were conducted at this plot in late spring of 2000. They indicated only sub-outbreak population levels. In 2000, trap catches at the Pistol Creek plot were much less, averaging 13.8 moths per trap. Even though the Pistol Creek plot catches were less, trap catches overall for northwestern Montana increased from 1999, when a total of 53 moths (excluding Pistol Creek which accounted for 318 moths) were caught in 160 traps (32 plots). Without the Pistol Creek plot, the average catch per trap in 1999 was 0.3 moths. It was 1.7 moths per trap in 2000, excluding the Pistol Creek plot (69 moths).

Plot locations where the most moths were caught and numbers of moths were:

Pistol Creek (69), Petty Creek (49), Kerr Dam (43), Jette Lake (30), Polson-Lost Lake (17), Butler Creek (14), Lakeside (11), Big Fork (11), Polson-Hell Roaring (10). No moths were caught at only four of the 33 total plots.

Some levels of Douglas-fir tussock moth population may continue in 2001 in or near the defoliation on the Flathead Indian Reservation. Egg mass sampling indicated high levels on the eastern edge, but few live trees remain to serve as a food source for larvae. Also, the level of NPH virus infection of the egg masses is not known. No egg masses were found in any stands east (down wind) of the defoliation, including the Pistol Creek plot area.

Gypsy Moth

Detection level trapping for gypsy moth in Montana was continued in 2000. State-wide, one moth was caught near Livingston, in a total of approximately 1,600 sticky traps placed by four agencies--Montana Department of Agriculture, APHIS, Forest Service and the Montana Department of Natural Resources and Conservation.

Satin Moth

Though satin moth populations were low in western Montana in 1999, and no noticeable defoliation was observed, considerable activity was again seen in 2000. Cottonwoods and willows were defoliated in the Bearmouth, Drummond, Hall and Phillipsburg areas, all of which had experienced defoliation in 1998. Defoliation of cottonwoods was also observed in two new areas in 2000--along the Blackfoot River near the Mineral Hill Fishing Access east of Ovando and also north of Kalispell. Defoliation had not been seen previously in either of these two areas.

Forest Tent Caterpillar

Defoliation was observed on cottonwoods in several areas of northwestern Montana, including Libby, Superior, St. Regis, Missoula, Arlee, St. Ignatius and Kalispell.

Pine Needle Sheathminer

Approximately 4,850 acres of pine needle sheathminer defoliation was mapped north of Columbia Falls on ponderosa pine and lodgepole pine.

DISEASES

Root Diseases

Root diseases are the most significant disease agents of mortality and growth loss in Montana, mostly west of the continental divide. Because root diseases are diseases of the site, we see very little changes occurring from one year to the next. The most significant root diseases in Montana are Armillaria root disease (*Armillaria ostoyae* (Romagn.) Herink), laminated root disease (*Phellinus weirii* (Murr.) Gilb.), annosum root disease (*Heterobasidion annosum (*Fr.) Bref.), and brown cubical root and butt decay (*Phaeolus schweintizii* (Fr.) Pat.). The most susceptible tree species in Montana is Douglas-fir, with grand and subalpine firs taking a close second. The most resistant species are western larch, pines and western redcedar, with the remaining species falling somewhere along the gradient between susceptible and tolerant. Although root diseases cause significant amounts of mortality and growth loss, they are also a major agent influencing both structure and species composition across landscapes. Root diseases have greatly influenced succession of vegetation in our forests. This is especially evident in the absence of natural fire.

On sites where there is a mixed species component with root disease tolerant serals, root diseases tend to prolong the seral stage on those sites. Root diseases slowly thin out the more root disease-susceptible species (Douglas-fir and true firs), and favor the root disease-tolerant serals.

On grand fir/subalpine fir climax habitats, with a Douglas-fir forest type, low levels of root disease will actually push the stand towards climax faster than in the absence of root disease. This is due to the greater susceptibility of Douglas-fir to root diseases. Although grand fir and subalpine fir are fairly susceptible to root diseases, they are measurably more tolerant than Douglas-fir. Root disease on western redcedar/western hemlock climax sites will also push stands towards climax by weeding out the more root disease susceptible seral species on these sites (Douglas-fir and grand fir).

On sites with a root disease susceptible forest type and climax habitat, very high levels of root disease will maintain an early stand development. Root disease patches experience wave after wave of mortality as trees become large enough for their root systems to contact the inoculum on the site. Trees are unable to grow to a very large size before being killed by root disease.

Mortality from Douglas-fir bark beetle continues to be high in various spots in Montana, which has raised some issues regarding management for Douglas-fir bark beetle (DFB) in root diseased areas. Douglas-fir infected with root disease often harbors endemic levels of DFB which likely aids in the rise of the DFB populations during an outbreak.

Annosum root disease of ponderosa pine is less evident than the above root diseases, but very important in local areas. It has been found causing mortality in ponderosa pine plantations in various locations on the Darby RD, Bitterroot NF, private lands west of Kalispell, and continues to be a significant agent on the Flathead Indian Reservation.

Dwarf Mistletoes

Dwarf mistletoes (*Arceuthobium* sp.) are parasitic plants that extract water and nutrients from living conifer trees. The dwarf mistletoes are native components of western coniferous forests, having co-evolved with their hosts for millions of years. The different dwarf mistletoes are generally host specific. In Montana, lodgepole pine and larch dwarf mistletoes occur throughout the range of their respective hosts while Douglas-fir mistletoe occurs only in the range of its host west of the Continental Divide.

Because dwarf mistletoes are obligate parasites, ecological forces that have patterned the development of the host tree species have also played roles in influencing the distribution of dwarf mistletoes across the landscape. Fire is one of those influential ecological forces. In general, any fire event that kills host trees will reduce the population of dwarf mistletoes, at least in the short term. The larger and more continuous the fire disturbance, the greater the reduction in dwarf mistletoe populations at the landscape level. Large, complete burns will greatly reduce dwarf mistletoe populations across the landscape and may even eliminate small, localized populations. Small, "patchy" burns will temporarily reduce portions of dwarf mistletoe populations, but infected residuals provide a ready source of dwarf mistletoe seeds for the infection of the newly developing regeneration.

Human influences, including fire suppression and logging, have also had effects on dwarf mistletoe population dynamics. Partial cutting, which created multi-storied stands, and fire suppression may have served to increase the severity of dwarf mistletoes relative to the "pre-settlement" condition. Conversely, dwarf mistletoes may have been reduced in certain age classes, habitat types, elevation zones or topographic positions that have been intensively managed. Fire suppression and cutting practices that have encouraged shifts in species compositions could have either increased or decreased the disease severity depending on what species of trees and dwarf mistletoes occurred on any given site.

The parasitic activity of dwarf mistletoes causes reduced tree diameter and height growth, decreased cone and seed production, direct tree mortality, or predisposition to other pathogens and insects. It has been estimated that in Montana lodgepole pine causes an average growth loss of 10.5 ft^3/acre/year and larch and Douglas-fir dwarf mistletoes cause average growth losses of 20 ft^3/acre/year in areas where they occur. On the other hand, witches' brooms and tree mortality may result in greater structural diversity and increased animal habitat. Dwarf mistletoe flowers, shoots and fruit are food for insects, birds and mammals. Witches' brooms may be used for hiding, thermal cover, and nesting sites by birds and other mammals. In the long term, heavily infested stands of the host trees can begin to decline, resulting in a successional shift toward other tree species.

Heartwood Stem Decays

The main function of heartwood in live trees is to give individual trees vertical stability. The decay of heartwood weakens this vertical stability, making trees more susceptible to stem breakage. Stem breakage can lead to mortality and subsequent formation of small-scale canopy gaps. The main successional functions of heartwood stem decays are to move stands from a mature closed canopy to a more open canopy and to perpetuate such an open canopy.

Stem decays are important in the creation of wildlife habitat in living trees. Although primary cavity nesters are capable of excavating in sound wood, they selectively excavate in trees and snags with heartwood decay. Most primary cavity nesters do not reuse their holes from one year to the next. Their previous year's holes are then used by a multitude of secondary cavity nesters, which are very dependent on already-created holes for successful reproduction. Thus, cavity-nesting habitat (i.e. heartwood decay) is necessary for the successful reproduction of a number of animal species.

Heartwood decay fungi are also necessary for the formation of hollow trees, which are also important habitat for a number of animal species. Hollow trees are created when decay fungi invade the heartwood of a living tree. The decay may progress to the point that the cylinder of decayed heartwood eventually detaches from the sapwood and slumps down, leaving a hollow chamber. The only way to obtain a hollow dead tree or log is to start with a living tree hollowed out by decay.

Foliage Diseases

Most fungi causing foliage diseases are confined to the needles and leaves, a few attack buds and some also invade young twigs. Foliage diseases are generally more severe in the lower canopy on seedlings, saplings, and small poles than on larger trees. Most of the fungi affect either foliage of the current season or older foliage, but rarely both; it is unusual for all the foliage in either category to be involved. The fungi vary in virulence from year to year according to climatic conditions; heavy infection over a period of years is exceptional. Some trees in a stand are severely infected, but others escape with little or no infection, apparently because of individual resistance. Foliage diseases rarely cause mortality, but they do cause a reduction in growth.

Elytroderma needle blight

Elytroderma needle blight (*Elytroderma deformans* (Weir) Darker) is the most damaging foliage disease on ponderosa pine in Montana. The fungus infects and kills needles, but it also invades twigs, and causes localized brooms.

Spores of the fungus mature in late summer and fall and are dispersed when the needles are wet. The fungus can live from year to year in invaded bark, so the disease can be perpetuated without conditions favorable for either spore production or infection of new needles.

Localized areas of heavy infection from Elytroderma needle blight were seen across western Montana in 2000. Elytroderma has been heavy in several locations in Montana for a number of years: Jette Lake area north of Polson, Bitterroot Valley south of Missoula, and the Belt Creek Canyon east of Great Falls.

Rhabdocline needle cast of Douglas-fir

Defoliation from *Rhabdocline pseudotsugae* Syd. continued to be severe in localized areas across the state in 2000. A single attack from *Rhabdocline* usually results in only partial defoliation. Trees subjected to several consecutive years of attack may be completely defoliated and killed or severely restricted in growth. The greatest damage is to Christmas trees; even partial defoliation makes them unsalable for a few years. Spores are produced on needles infected the previous year and infect the current year's needles in May or June. Symptoms develop in early winter, the fungus matures early the next spring, sporulates, and needles are cast during the following summer.

DECLINES

Limber Pine Decline

Limber pine mortality is continuing across scattered locations in central and eastern Montana, but the rate of mortality appears to be slowing. Permanent plots have been established at various locations near Stanford, Monarch, Clyde Park, and Dewey. Data from these plots indicate that mortality is strongly associated with severe defoliation from *Dothistroma* needle blight (*Dothistroma septospora* (Dorog.) Morelet). Defoliation from *Dothistroma* was substantially lower at all plot locations in 2000. However, for the first time since plot establishment, *Lophodermella arcuata* (Darker) Darker caused severe defoliation on plots near Stanford. Other factors thought to be contributing to the limber pine decline are winter damage, drought and competition related stress.

HAZARD TREE MANAGEMENT IN RECREATION SITES

FHP has increased its efforts to provide technical assistance to land managers in the area of hazard trees in recreation sites. Specifically, we provide assistance in the form of site evaluations and on-site training. In 2000 we provided training to the Lewis and Clark National Forest and Yellowstone National Park. A new form has been developed which aids in the evaluation of hazard trees and assures proper documentation of the evaluation process. Anyone requesting assistance in hazard tree management should contact Jane Taylor (406-329-3463) or John Schwandt (208-765-7415).

APPENDIX

FOREST HEALTH PROTECTION PERSONNEL

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COMMON AND SCIENTIFIC NAMES

Diseases

Annosum root disease	*Heterobasidion annosum* (FR.) Bref.	Primary hosts: DF, GF, PP, SAF
Armillaria root disease	*Armillaria ostoyae* (Romagn.) *Herink*	DF, GF, SAF, sapling pines
Atropellis canker	*Atropellis piniphila* (Weir) Lohn. and Cash	LPP
Brown cubical butt rot	*Phaeolus schweinitzii* (Fr.) Pat..	DF
Comandra rust	*Cronartium comandra* Peck.	LPP,PP
Diplodia blight	*Sphaeropsis sapinea* (Fr.) Dyko.	PP
Dutch elm disease	*Ophiostoma ulmi* (Buism.) Nannf.	American elm
Dwarf mistletoes	*Arceuthobium* spp.	LPLP, DF, WL
Brown Stringy rot	*Echinodontium tinctorium*	G, WH
Elytroderma needle cast	*Elytroderma deformans* (Weir) Darker	PP
Fusarium root rot	*Fusarium oxysporum* Schlect.	DF (Nursery)
Grey mold	*Botrytis cinerea* Pers. Ex Fr.	WL (Nursery)
Larch needle blight	*Hypodermella laricis* Tub.	WL
Larch needle cast	*Meria laricis* Vuill.	WL
Laminated root rot	*Phellinus weirii* (Murr.) Gilb.	DF, GF, WH, SAF
Lodgepole pine needle cast	*Lophodermella concolor* (Dear.) Dark	LPP
Pini rot	*Phellinus pini* (Thore:Fr.) Pilet.	DF, WL, ES, All pines
Sirococcus tip blight	*Sirococcus strobilinus* Preuss	WWP (Nursery)
Swiss needle cast	*Phaeocryptopus gaeumannii* (Rhode) Petrak	DF
Western gall rust	*Endocronartium harknessii* (Moore) Hirta.	LPP, PP
White pine blister rust	*Cronartium ribicola* Fisch.	WWP, WBP
Rhabdocline needle cast	*Rhabdocline pseudotsugae* Syd.	DF

Insects

Douglas-fir beetle	*Dendroctonus pseudotusugae* Hopkins	DF
Douglas-fir tussock moth	*Orygia pseudotsugata (*McDunnough*)*	DF, TF, ES
Gypsy moth	*Lymantria dispar (*Linaeus*)*	Most hardwoods
Mountain pine beetle	*Dendroctonus ponderosa* Hopkins	All pines
Pine engraver beetle	*Ips pini* (Say)	PP, LPP
Spruce beetle	*Dendroctonus rufipennis* Swaine	ES
Western balsam bark beetle	*Choristoneura occidentalis* Freeman	SAF
Western spruce budworm	*Dendroctonus brevicomis* LeConte	DF, TF, ES, WI
Western pine beetle	*Scolytis ventralis* LeConte	PP
Fir engraver beetle	*Pissodes terminalis* Hopping	GF, SAF
Lodgepole terminal weevil	*Adelges piceae* (Ratzeburg)	LPP
Balsam woolly adelgid	*Dsaychira plagiata*	SAF, GF
Pine tussock moth	*Neodiprion autumnalis*	PP
Sawflies	*Rhyacionia* species	PP

DF = Douglas-fir; GF = Grand fir; TF = True fir; SAF = Subalpine fir; PP = Ponderosa pine; LPP = Lodgepole pine; WWP = Western white pine; ES = Engelmann spruce; WH = Western hemlock; WL = Western larch; MH = Most hardwoods; WRC = Western redcedar; WBP = Whitebark pine

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